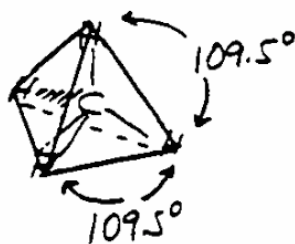
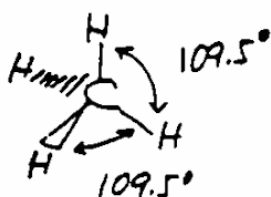


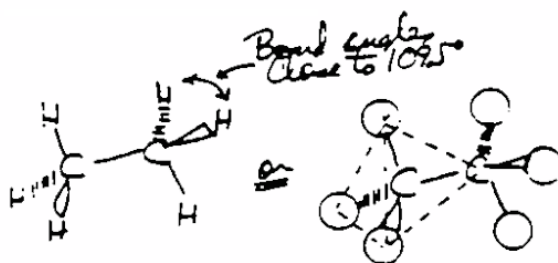
2.1. Different Types of Structures

<u>Name</u>	<u>Methane</u>	<u>Ethane</u>	<u>Propane</u>
<u>Kekulé's Structure</u>			
<u>Electron DOT Formula</u>			
<u>Three-Dimensional Structure</u>			
<u>Condensed Structural Formula</u>	CH ₄	CH ₃ CH ₃	CH ₃ CH ₂ CH ₃
<u>Molecular Formula</u>	CH ₄	C ₂ H ₆	C ₃ H ₈

2.2. C-H Bond Angles in Methane

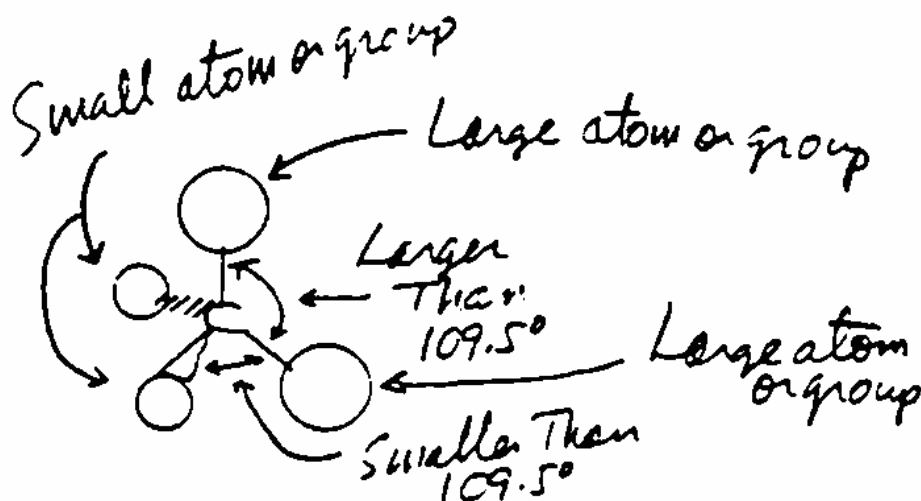
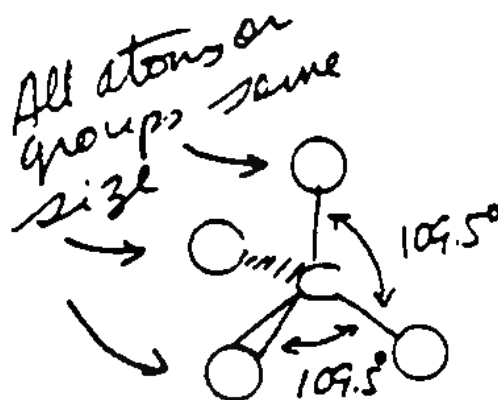


Ethane (CH₃-CH₃)

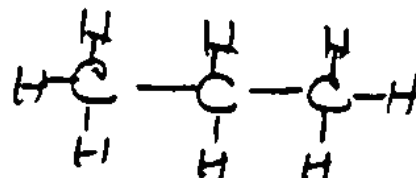
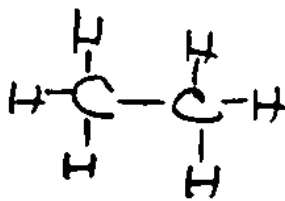
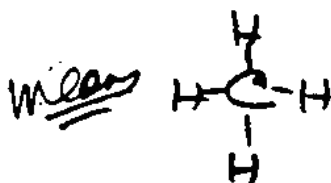
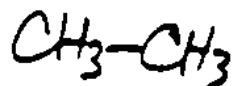
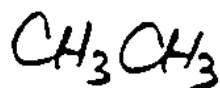


3-D Structures

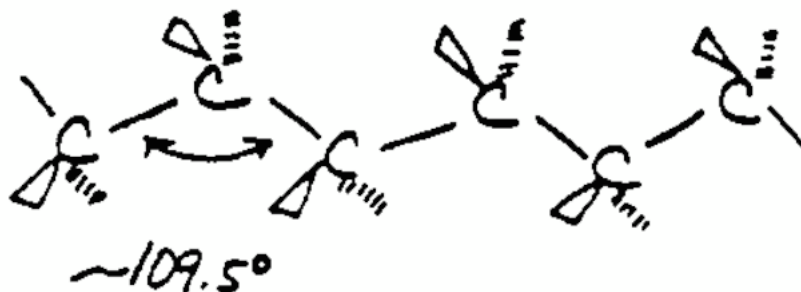
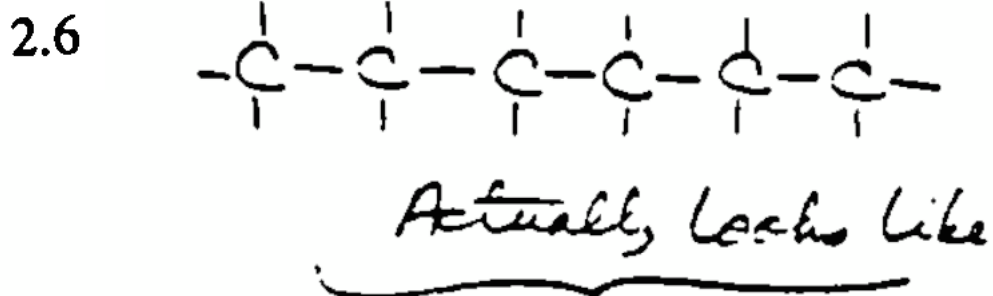
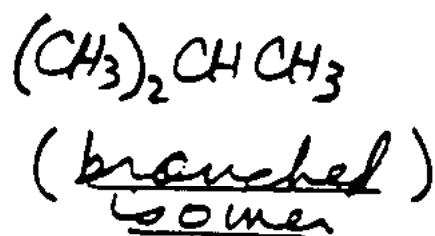
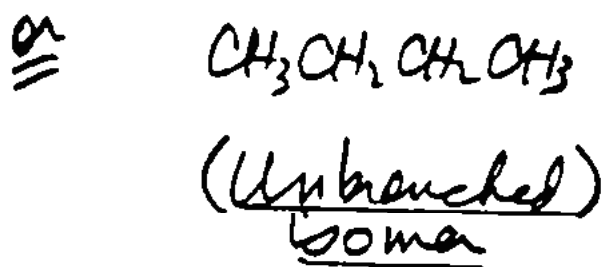
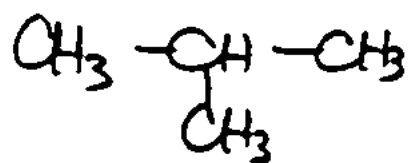
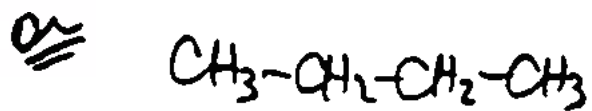
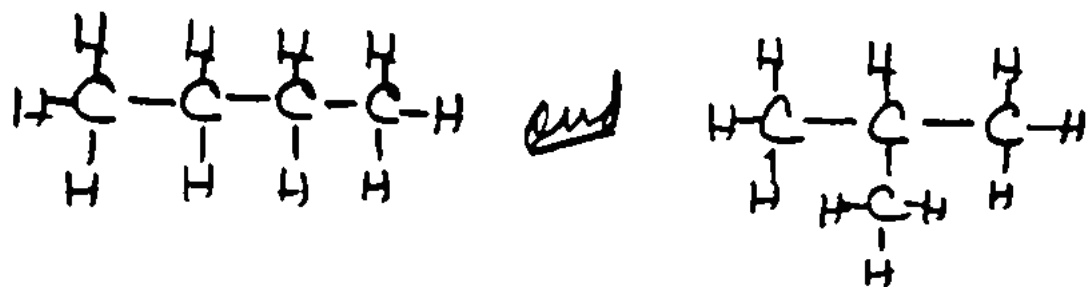
2.3



2.4. Condensed Structural Formulas

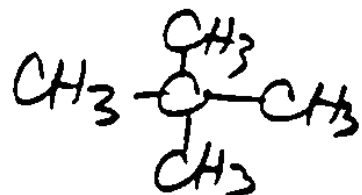
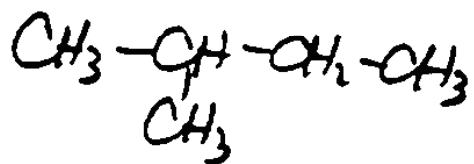
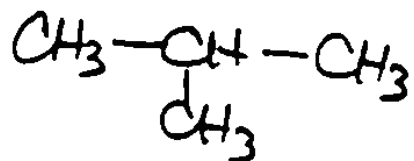
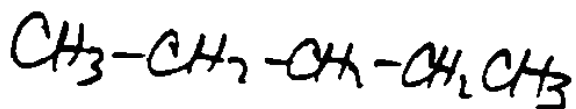
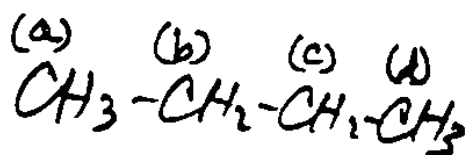


2.5. Structures Corresponding to C_4H_{10}

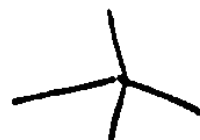
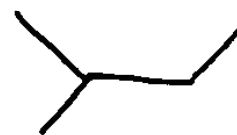
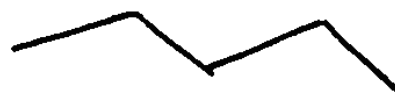
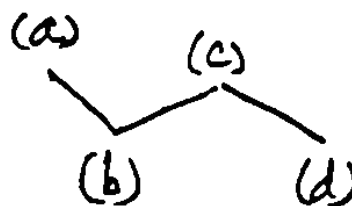


2.7. Line-Bond Drawings

Condensed
Structural
Formula

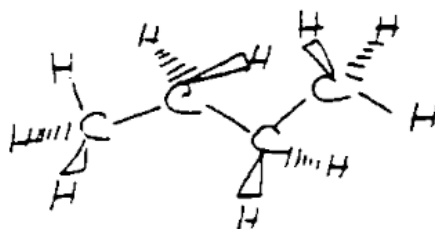


Line-Bond
Structure

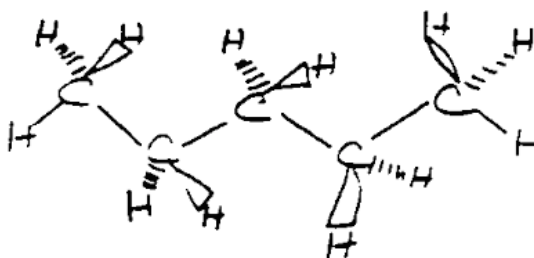


2.8. 3-D Structures of Butane and Pentane

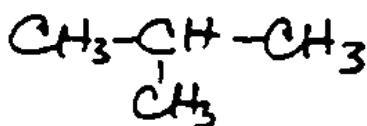
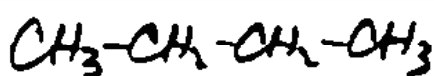
butane



Pentane



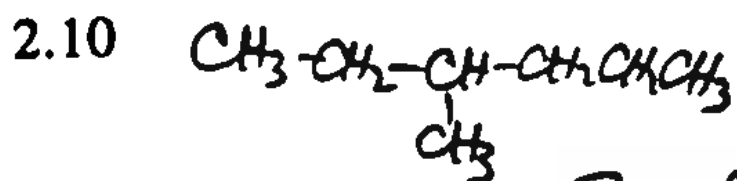
2.9. Names of C₄H₁₀ Isomers



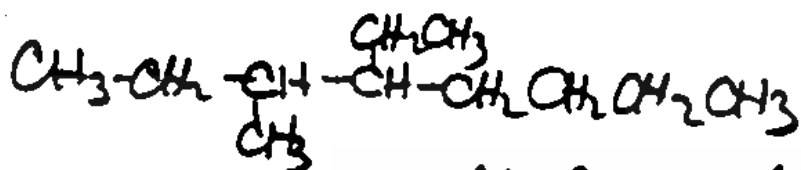
butane

2-methylpropane

2.10

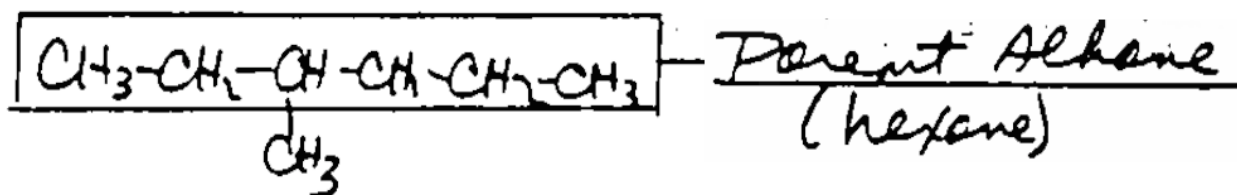


3-methylhexane

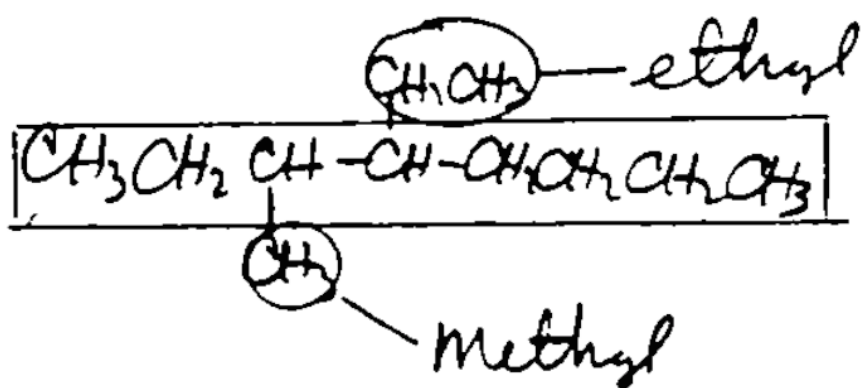
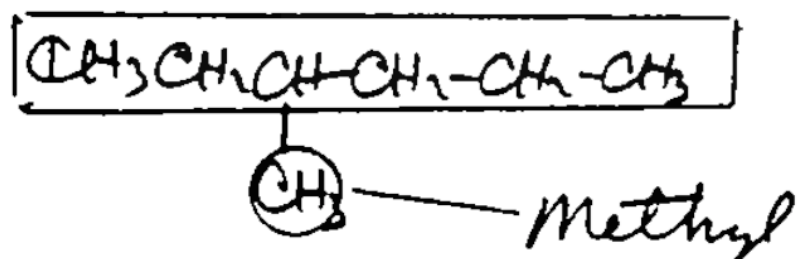


4-ethyl-3-methyloctane

2.11



2.12



2.13 Alkyl Group

Alkyl Group

CH_3-
methyl

methyl

Corresponding
Alkene

Methane

Methane

$$\text{CH}_3\text{CH}_2-$$

ethyl

ethyl

ethaneethane

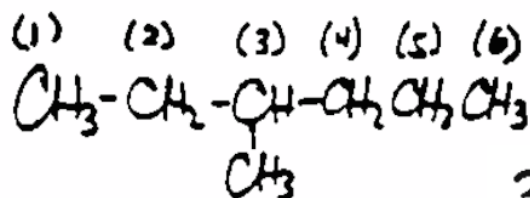
2.14

$$\begin{array}{cccccc} (1) & (2) & (3) & (4) & (5) & (6) \\ \text{CH}_3 & \text{CH}_2 & \text{CH} & -\text{CH}_2 & -\text{CH}_2 & -\text{CH}_3 \\ & & | & & & \\ & & \text{H} & & & \end{array}$$
$$\text{CH}_3 - \text{---} \text{ (3-methyl)}$$

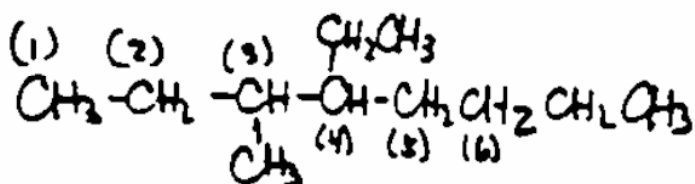
$$\begin{array}{ccccccc}
 \text{(1)} & \text{(2)} & \text{(3)} & & \text{CH}_2\text{CH}_3 & \text{---} & \text{(4-ethyl)} \\
 \text{CH}_3 & \text{---} & \text{CH} & \text{---} & \text{CH} & \text{---} & \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \\
 & & | & & \text{(4)} & \text{(5)} & \text{(6)} & \text{(7)} & \text{(8)} \\
 & & \text{CH}_3 & & & & & &
 \end{array}$$

 (3-methyl)

2.15

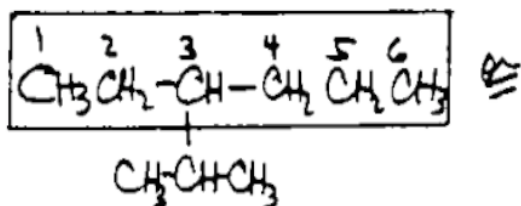
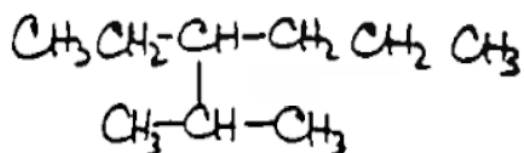


3-methylhexane

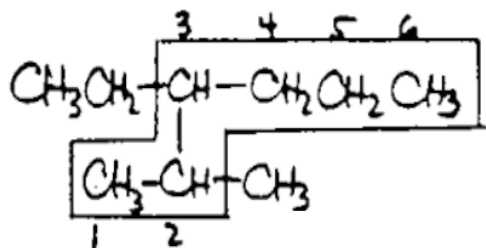


4-ethyl-3-methyloctane

2.16



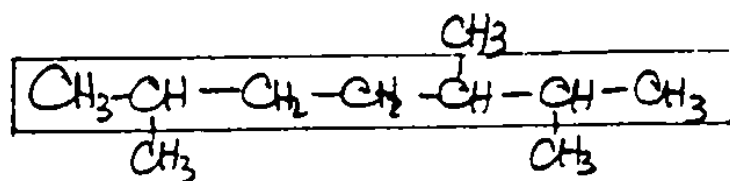
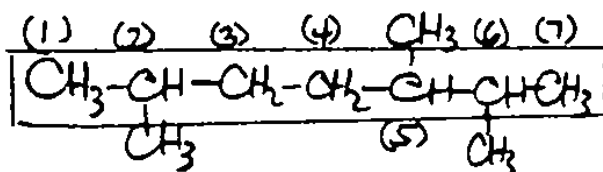
- hexane parent alkane
- one alkyl group
- No!!



- hexane parent alkane
- two alkyl groups
- yes!!

3-ethyl-2-methylhexane

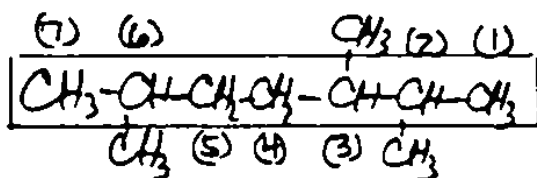
2.17

Parent
alkane
(heptane)

2-methyl

5-methyl

6-methyl

NO!!

2-methyl

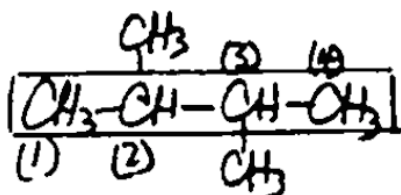
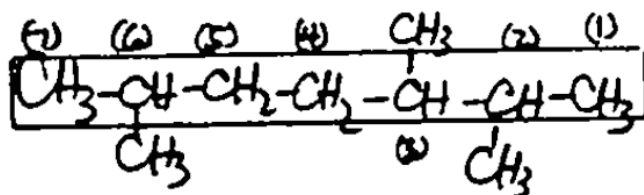
3-methyl

6-methyl

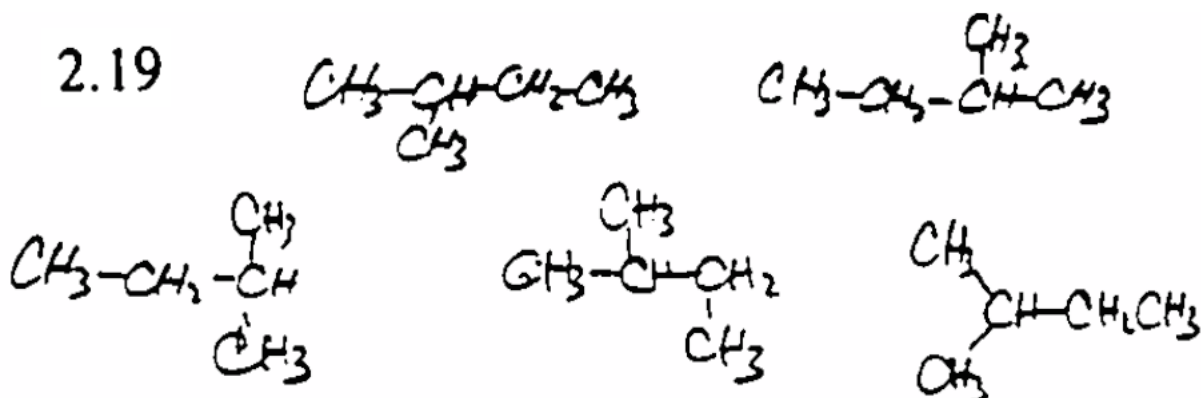
Yes!!

3-methyl has lower
C number than
5-methyl

2.18

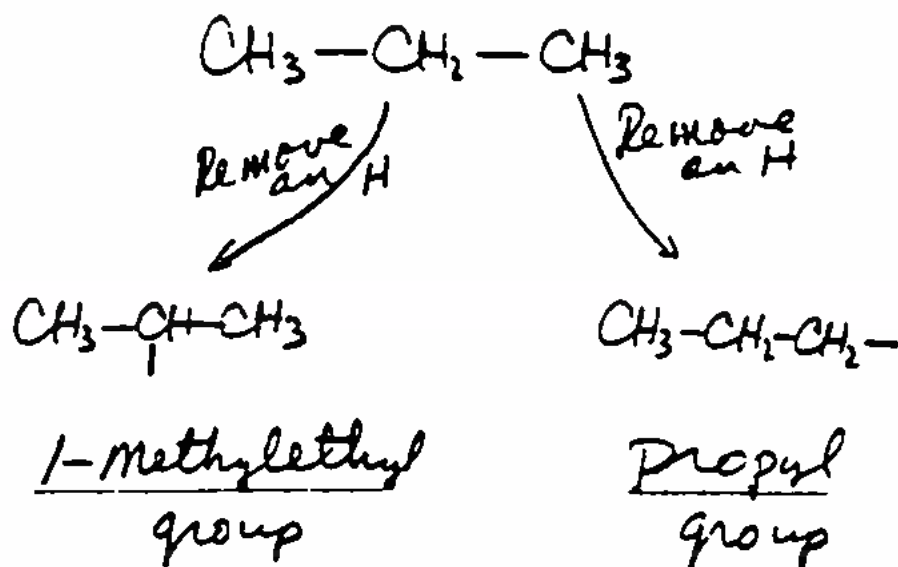
2,3-dimethylbutane2,3,6-trimethylheptane

2.19

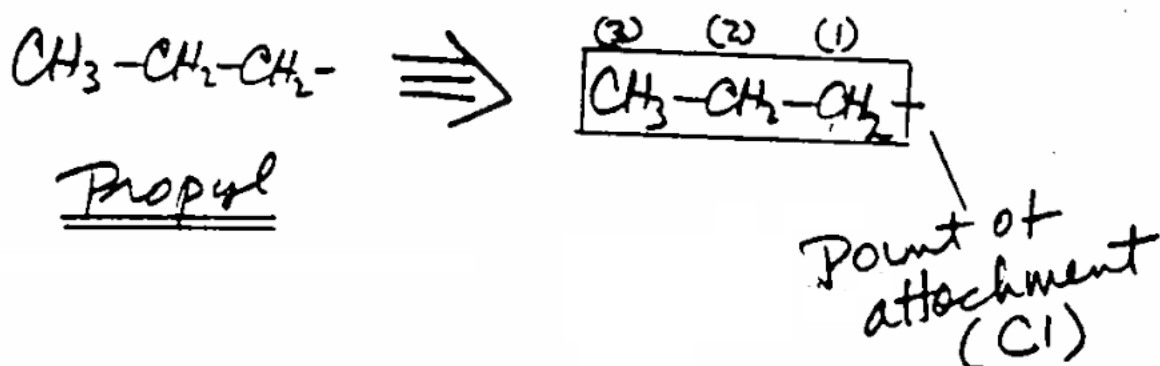


All of These are 2-methylbutane

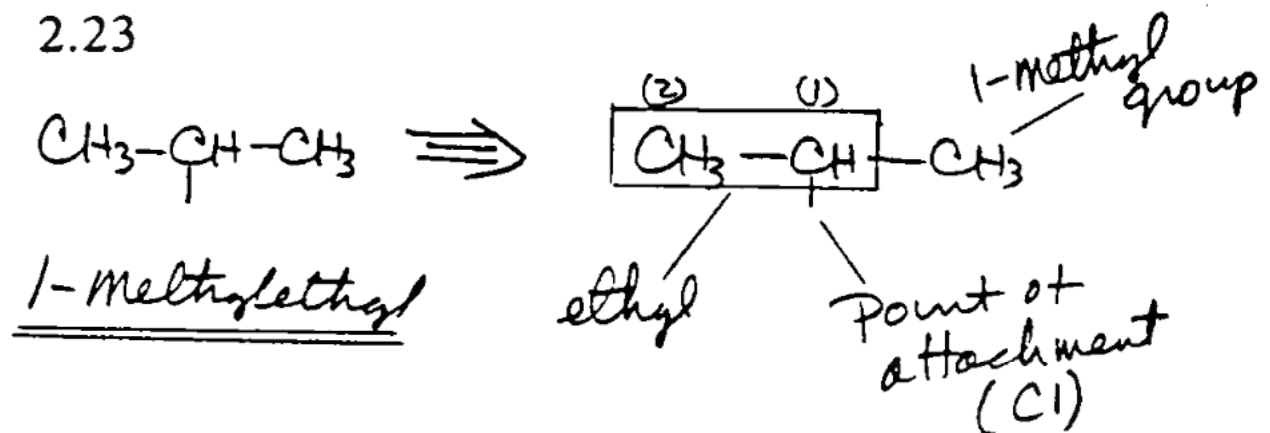
2.21. Formation of Alkyl Groups from Propane



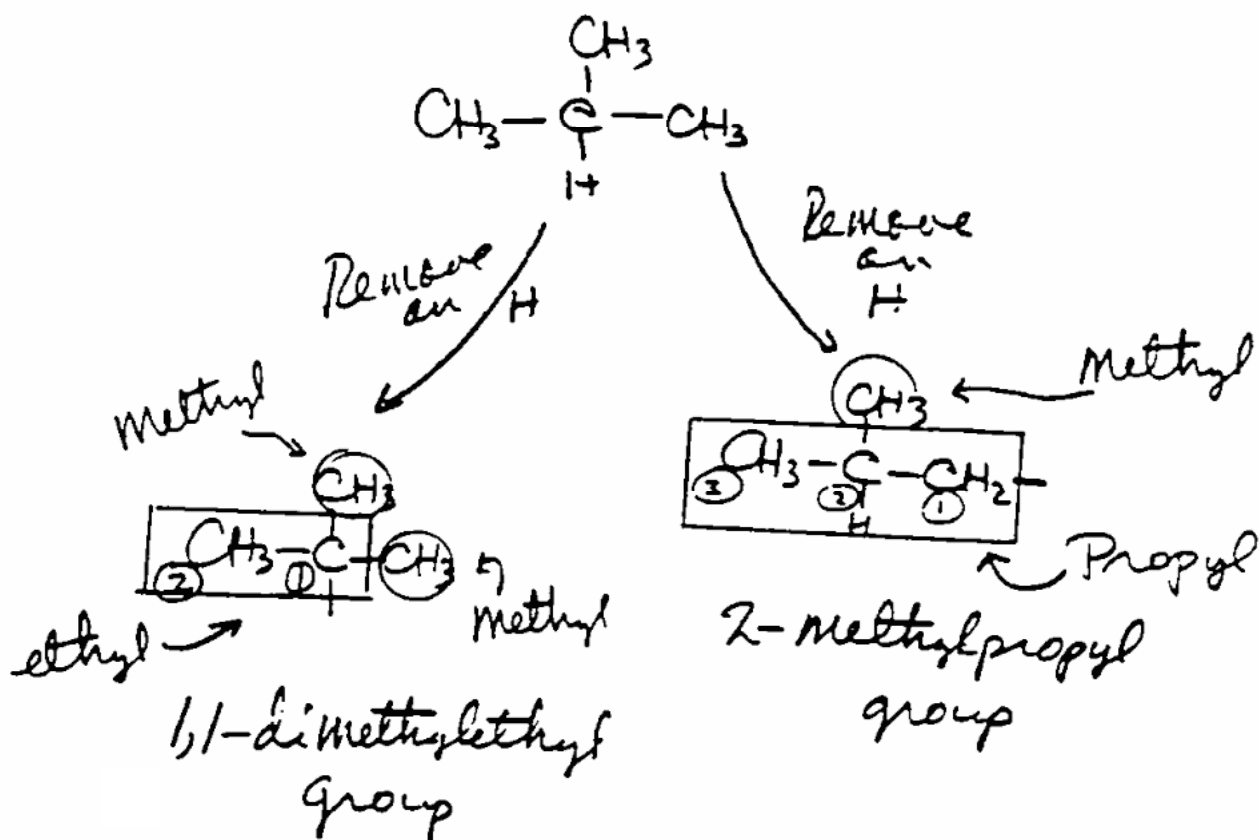
2.22



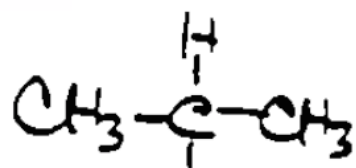
2.23



2.24. Formation of Alkyl Groups from 2-Methylpropane



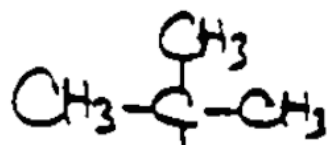
2.25



1-methylethyl

or

isopropyl

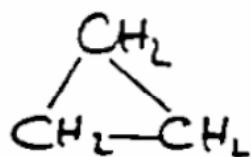


1,1-dimethylethyl

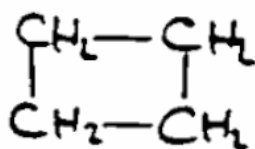
or

tert-butyl

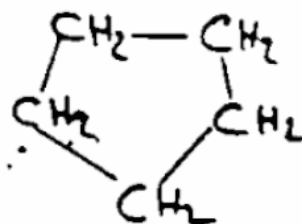
2.26. Some Cycloalkanes



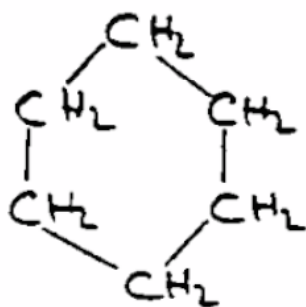
Cyclopropane
C₃



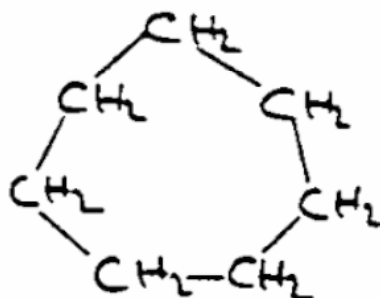
Cyclobutane
C₄



Cyclopentane
C₅

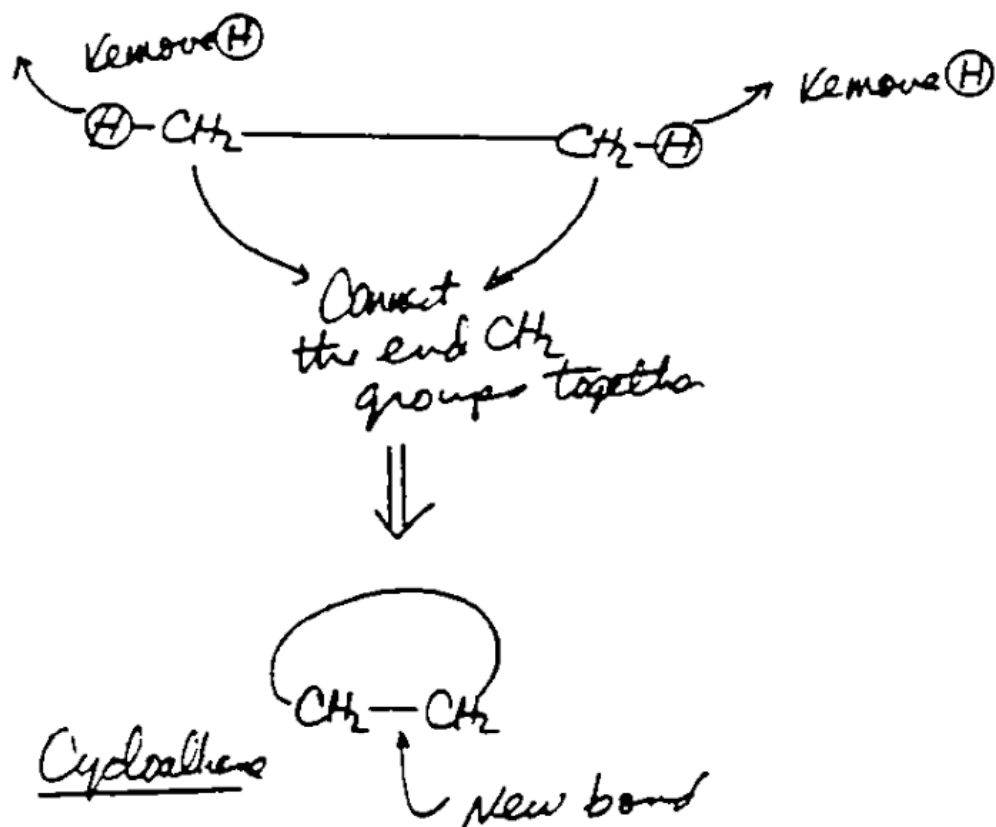


Cyclohexane
C₆



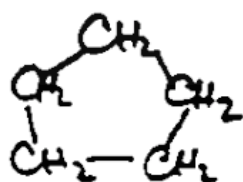
Cycloheptane
C₇

2.27. Formation of a Cycloalkane

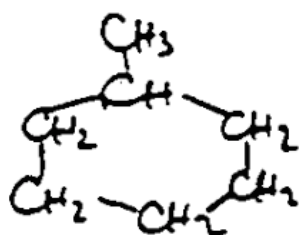
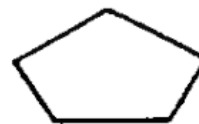


2.28

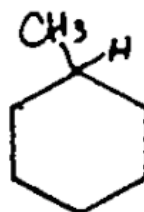
Cyclopentane



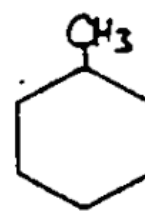
or



or

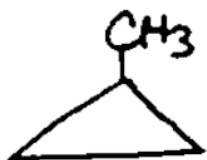


or

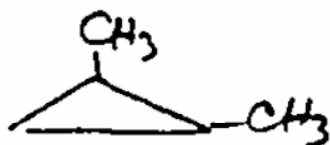


Methylcyclohexane

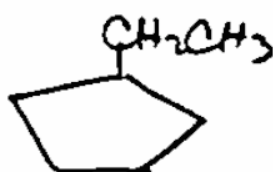
2.30



methylcyclopropane



1,2-dimethylcyclopropane

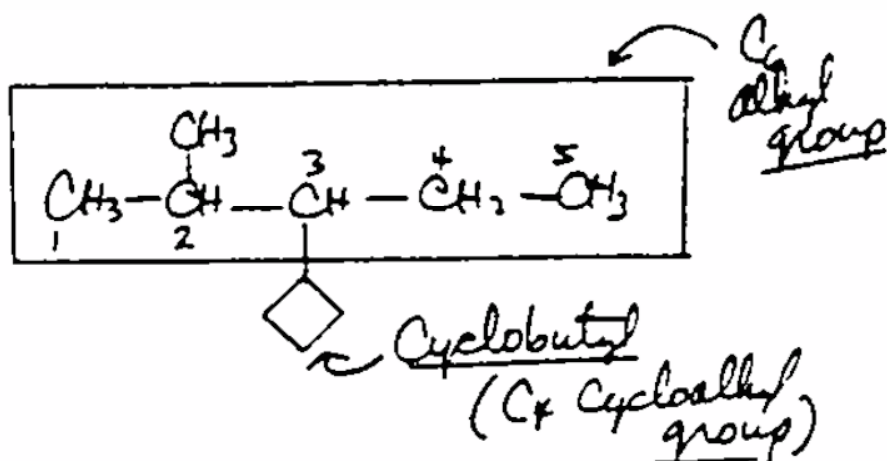


ethylcyclopentane



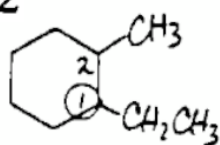
1-ethyl-2-methylcyclohexane

2.31

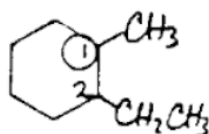


3-cyclobutyl-2-methylpentane

2.32



1-ethyl-2-methylcyclohexane

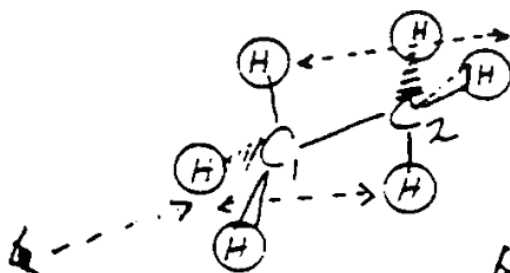
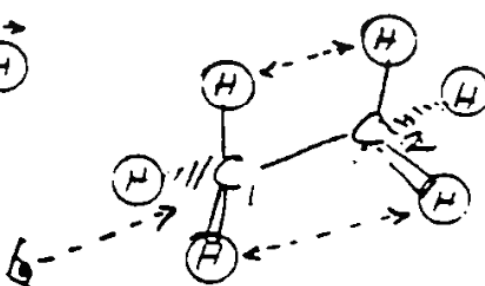
Correct!

2-ethyl-1-methylcyclohexane

Incorrect!

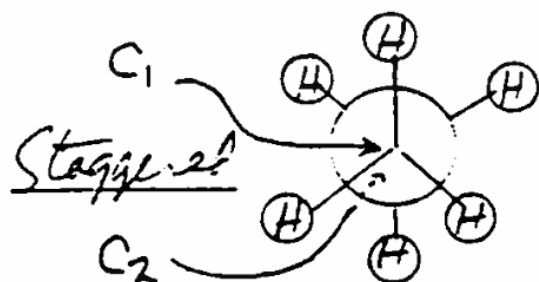
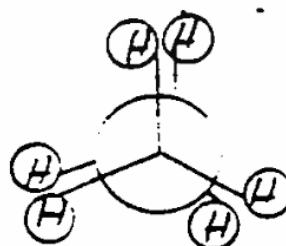
2.34

Staggered and eclipsed conformations of ethane showing "eyeballs" looking along the C1-C2 bonds.

StaggeredEclipsed

2.35

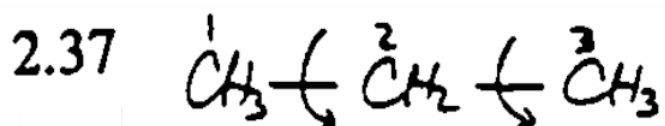
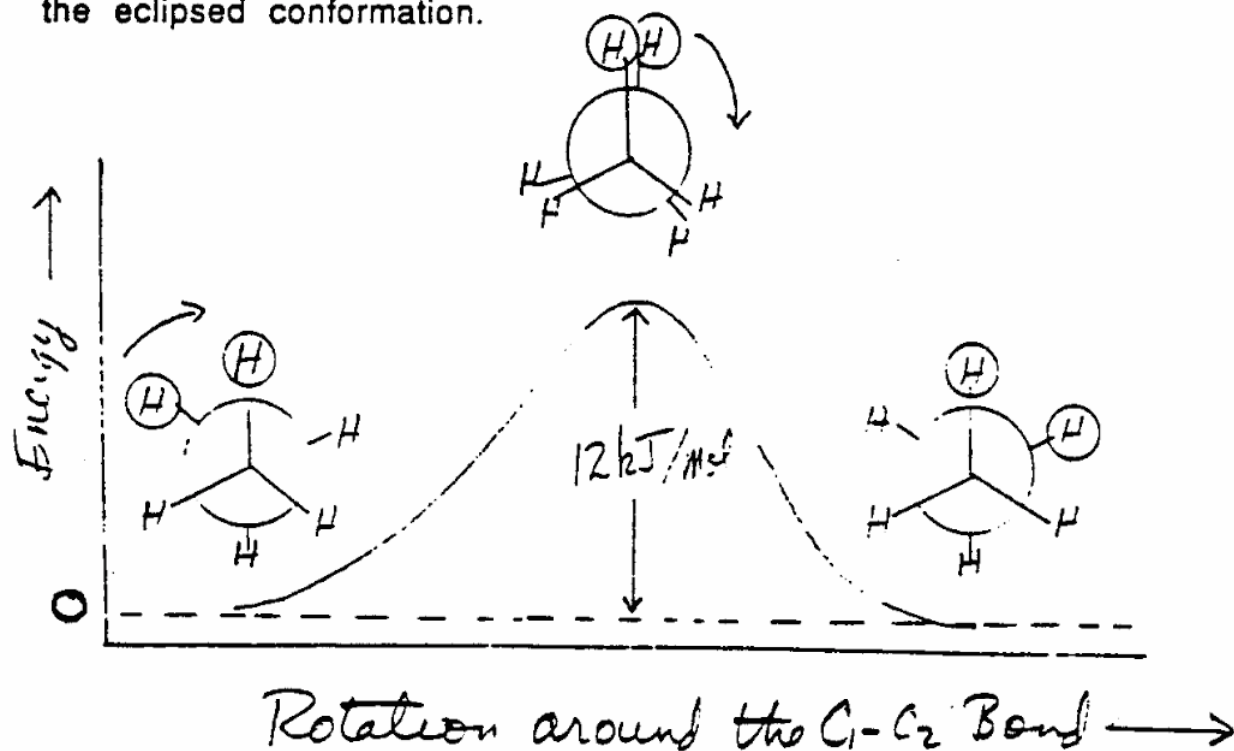
Newman projections of ethane. The viewer is looking along the C1-C2 bond of ethane shown in Figure 1.22. C1 is in front and C2 is behind C1.

Staggered!Eclipsed!

2.36

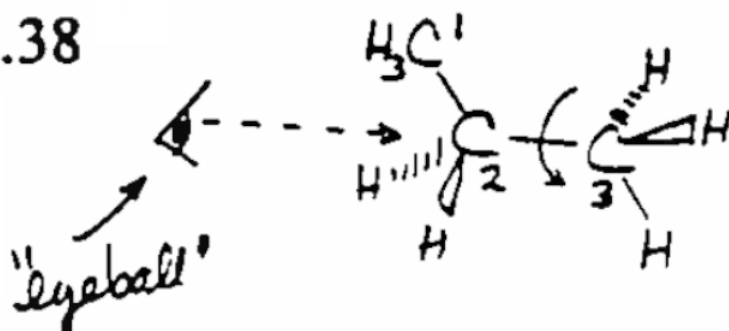
Energy diagram for rotation about the C1-C2 bond in ethane.

The staggered conformation has an energy 12 kJ/mol lower than that of the eclipsed conformation.



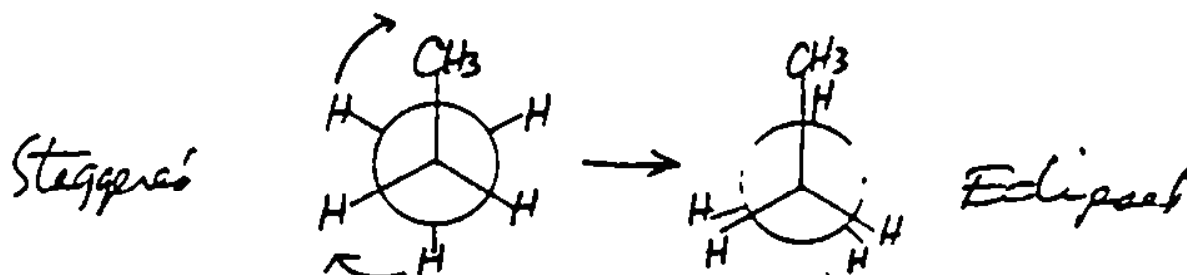
Rotation occurs about both C-C bonds

2.38

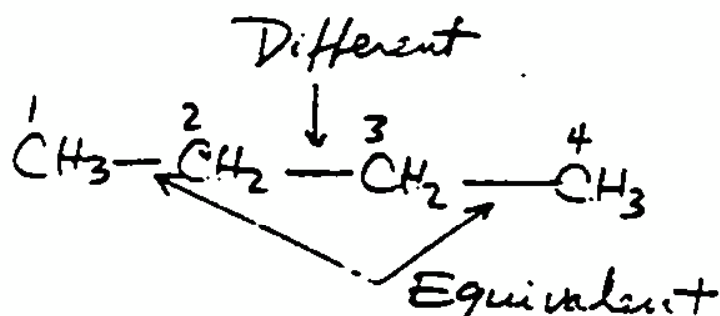


2.39

Newman projections for the staggered and eclipsed conformations resulting from rotation about the C2-C3 bond in propane.

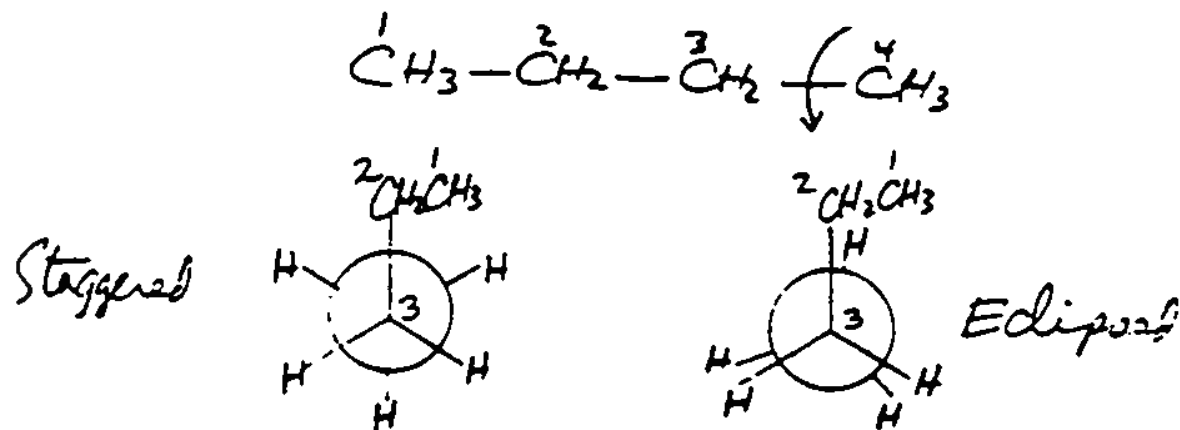


2.40

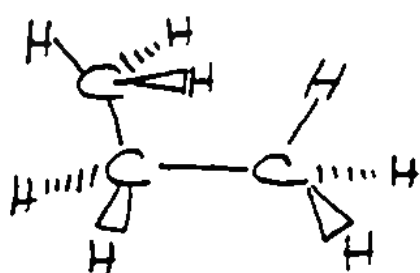


2.41

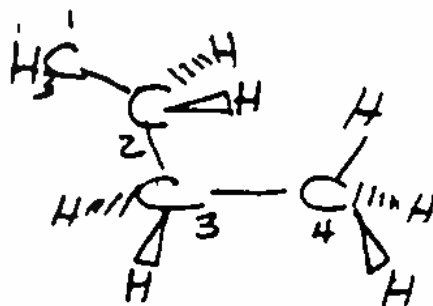
Newman projections for the staggered and eclipsed conformations resulting from rotation about the C3-C4 bond in butane.



2.41a



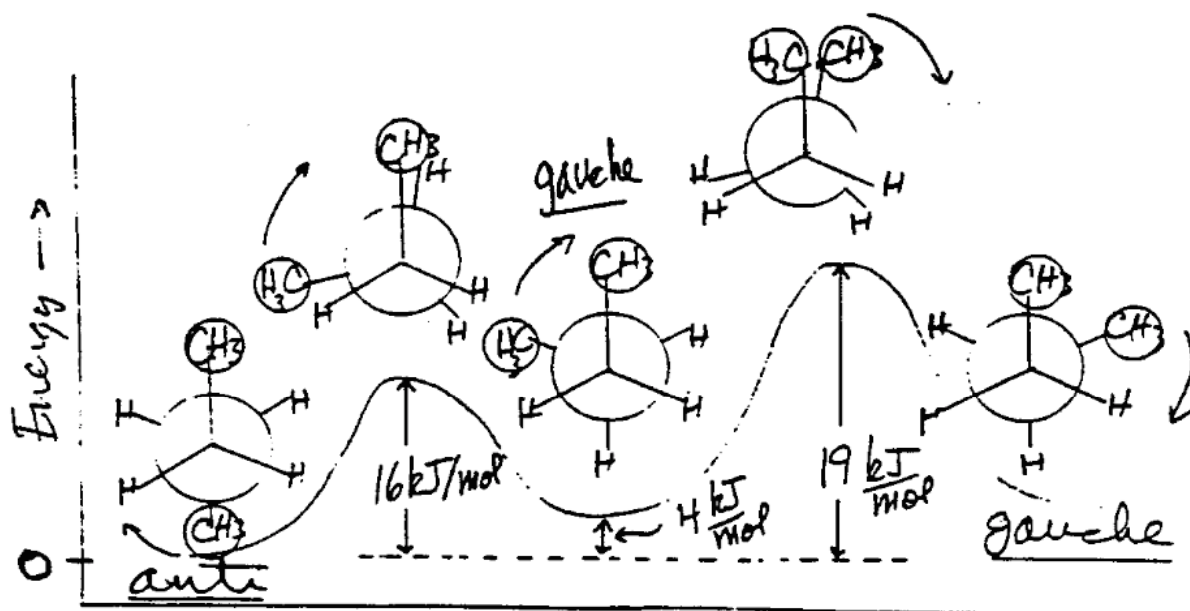
eclipsed
Conformation
of
Propane



eclipsed
Conformation
(C₃-C₄)
of
butane

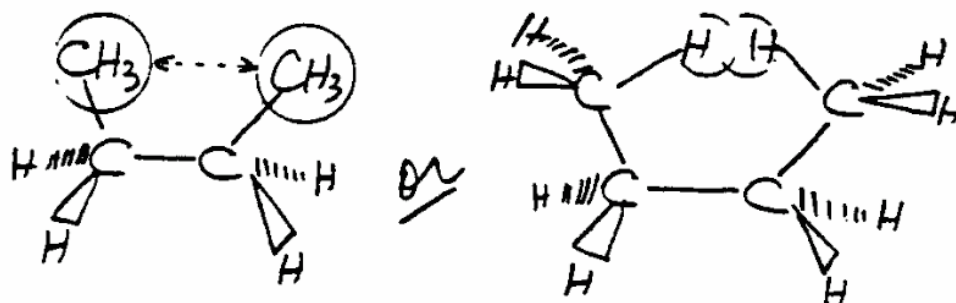
2.42

An energy diagram for the conformations resulting from rotation about the C2-C3 bond in butane. The Newman projections of these conformations are also shown.



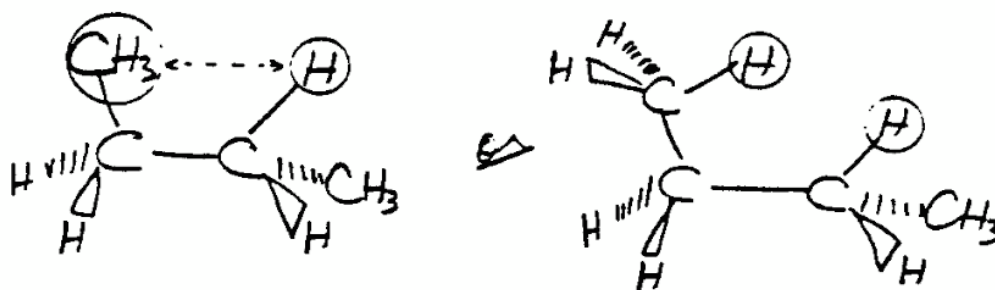
Staggered → Eclipsed → Staggered → Eclipsed → Staggered
(anti) (gauche) (gauche)

2.43



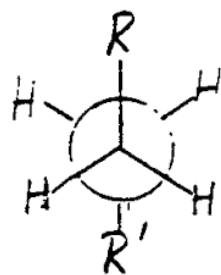
Eclipsed CH₃ Group,
Very Unfavorable
(+19 kJ/mol)

2.44

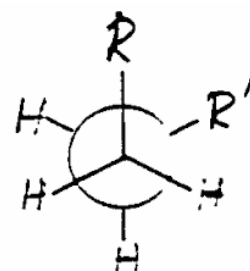
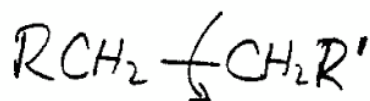


CH₃ and H Eclipsed
Less Unfavorable
(+16 kJ/mol)

2.45 Staggered conformations resulting from rotation about the indicated C-C bond of the general structure of an alkane (RCH₂-CH₂R').

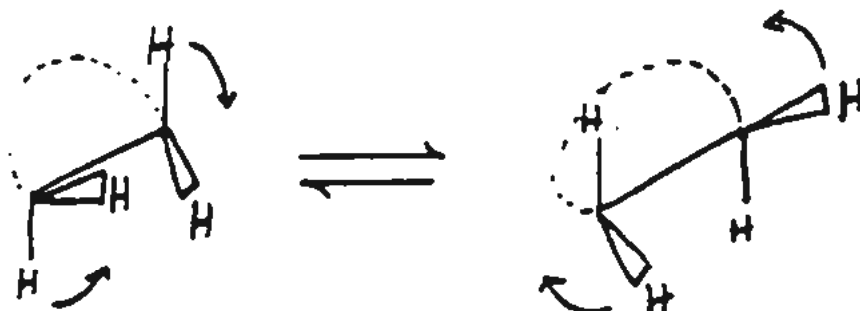


anti
R and R'

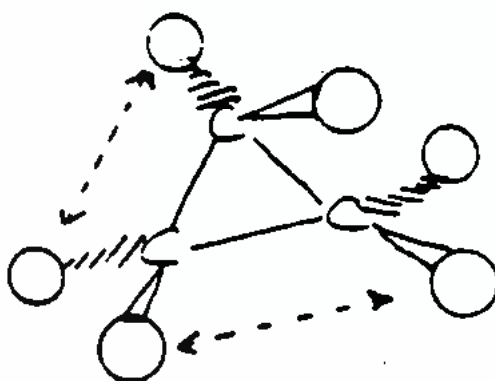


gauche
R and R'

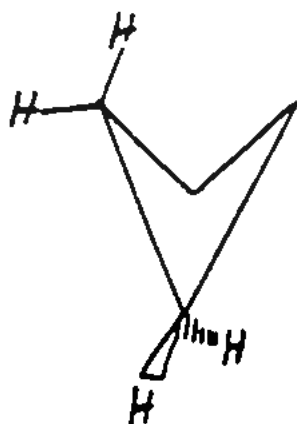
2.46 Rotation about the C-C bond in a ring causes the attached C-H bonds to rock back and forth between different conformations.



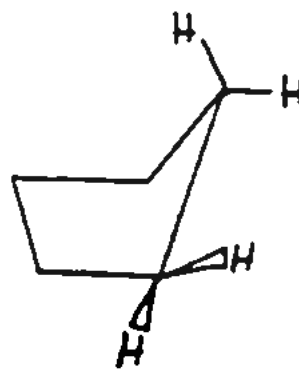
2.47 3-D structure of cyclopropane showing that all attached groups are eclipsed.



2.48

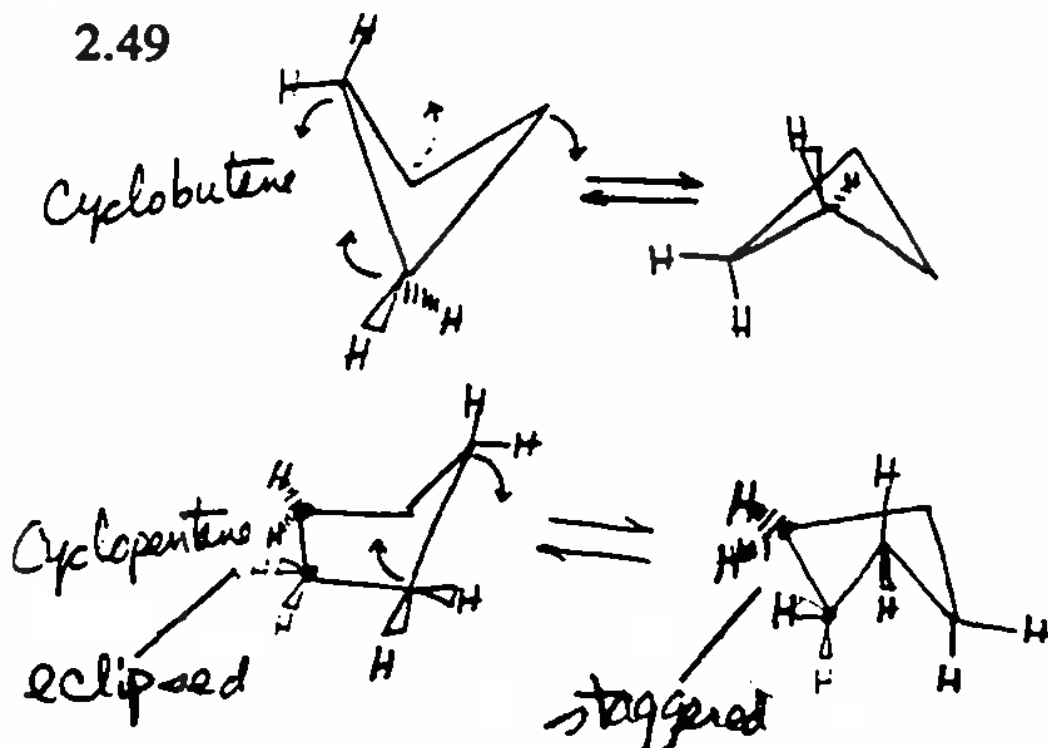


Cyclobutene

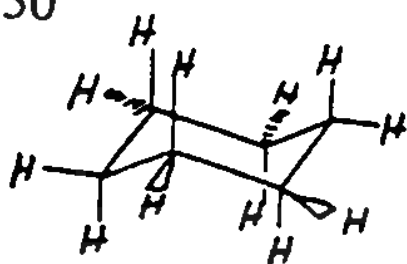


Cyclopentene

2.49

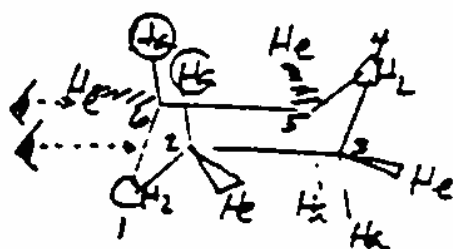


2.50

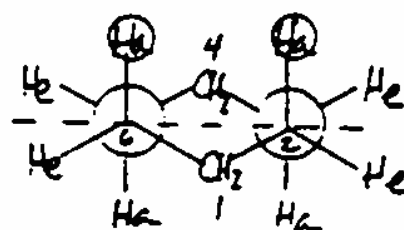


Chain Conformation
of
Cyclohexane

2.51 Cyclohexane chair conformations and "Newman-type" projection resulting from simultaneously looking down the C2-C3 and C6-C5 bonds.

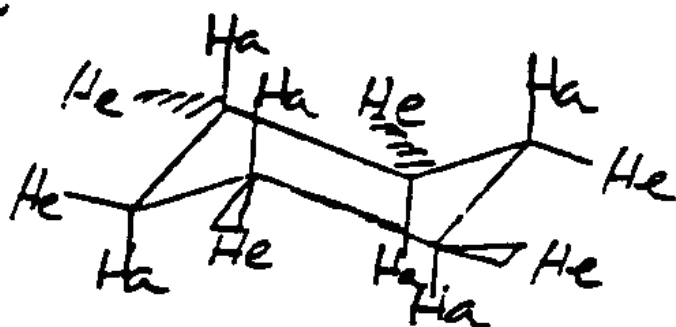


Chair form



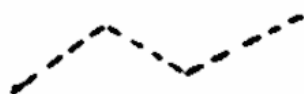
Newman-type Projection

2.52



2.53 A stepwise procedure for drawing chair conformations of cyclohexane.

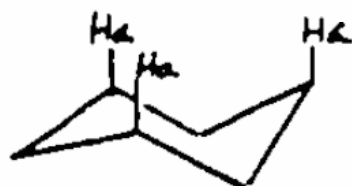
(1a)



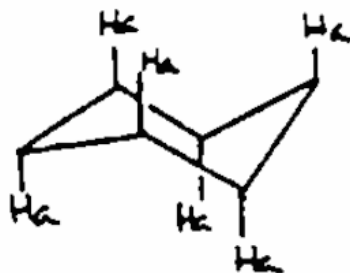
(1b)



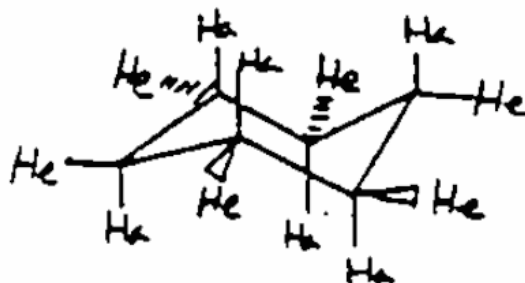
(2a)



(2b)

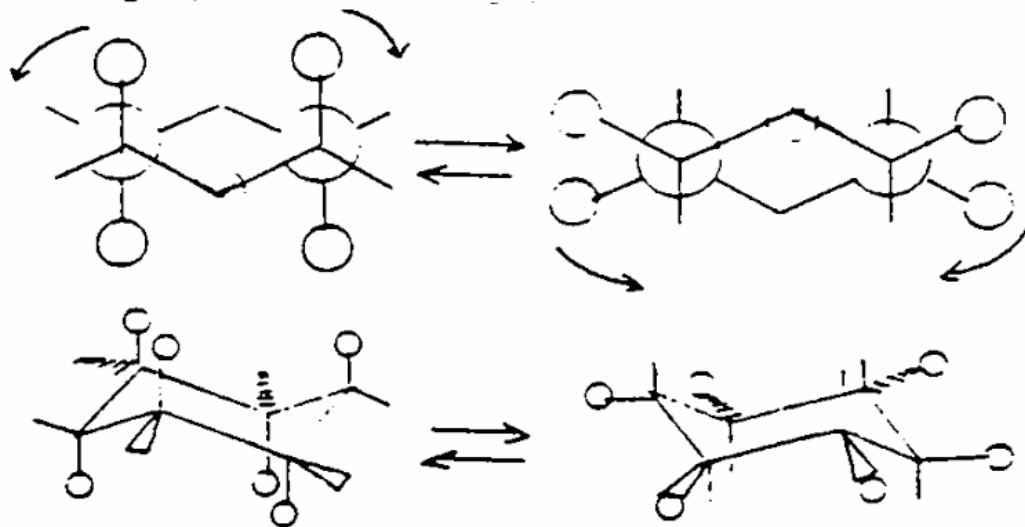


(3)



Note-
Use Colors to
distinguish
the Changes
in
each
step.

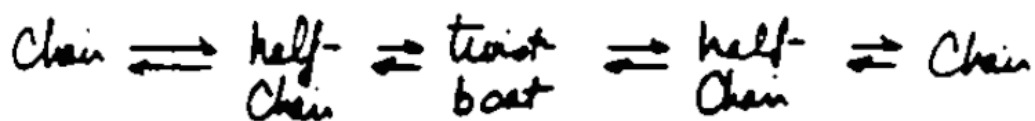
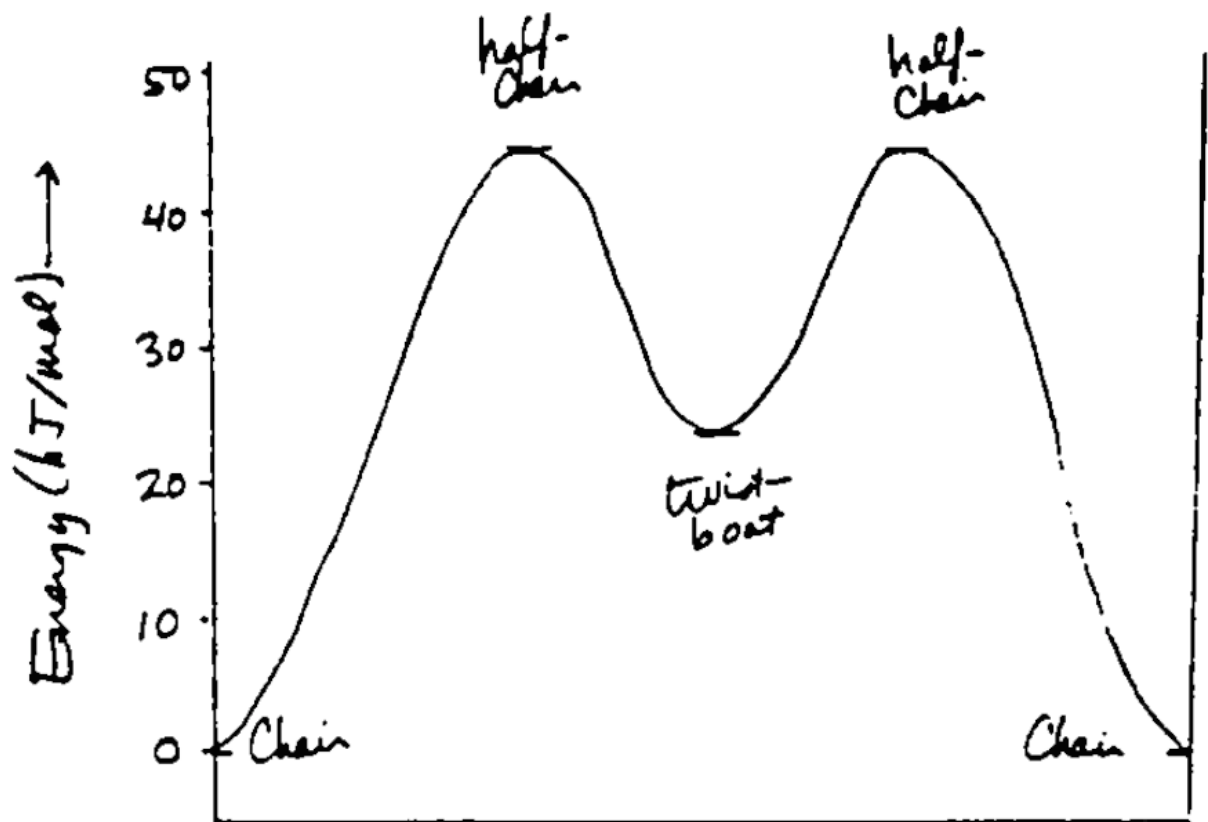
2.54 Ring-flipping of cyclohexane chair conformations causes groups attached to the ring to exchange their positions.



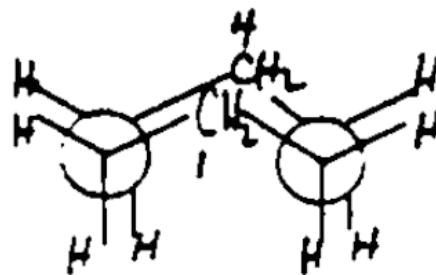
2.55

<u>Structure</u>	<u>Conformation Name</u> (Relative Energy)
	<u>Chair Conformation</u> (+ 0 kJ/mol)
	<u>Half-Chair Conformation</u> (+ 45 kJ/mol)
	<u>Boat Conformation</u> (+ 28 kJ/mol)
	<u>Twist-Boat Conformation</u> (+ 23 kJ/mol)

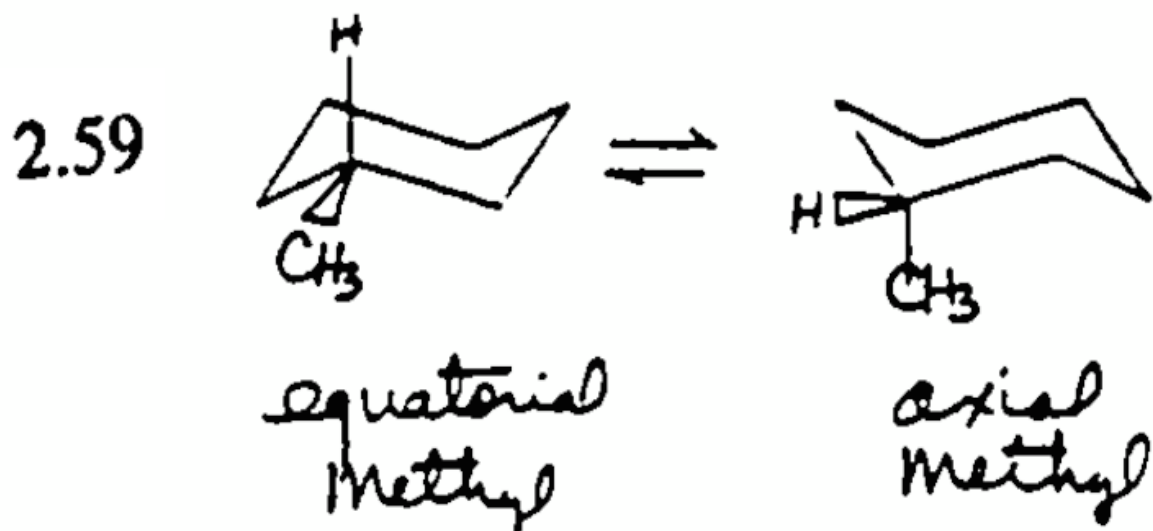
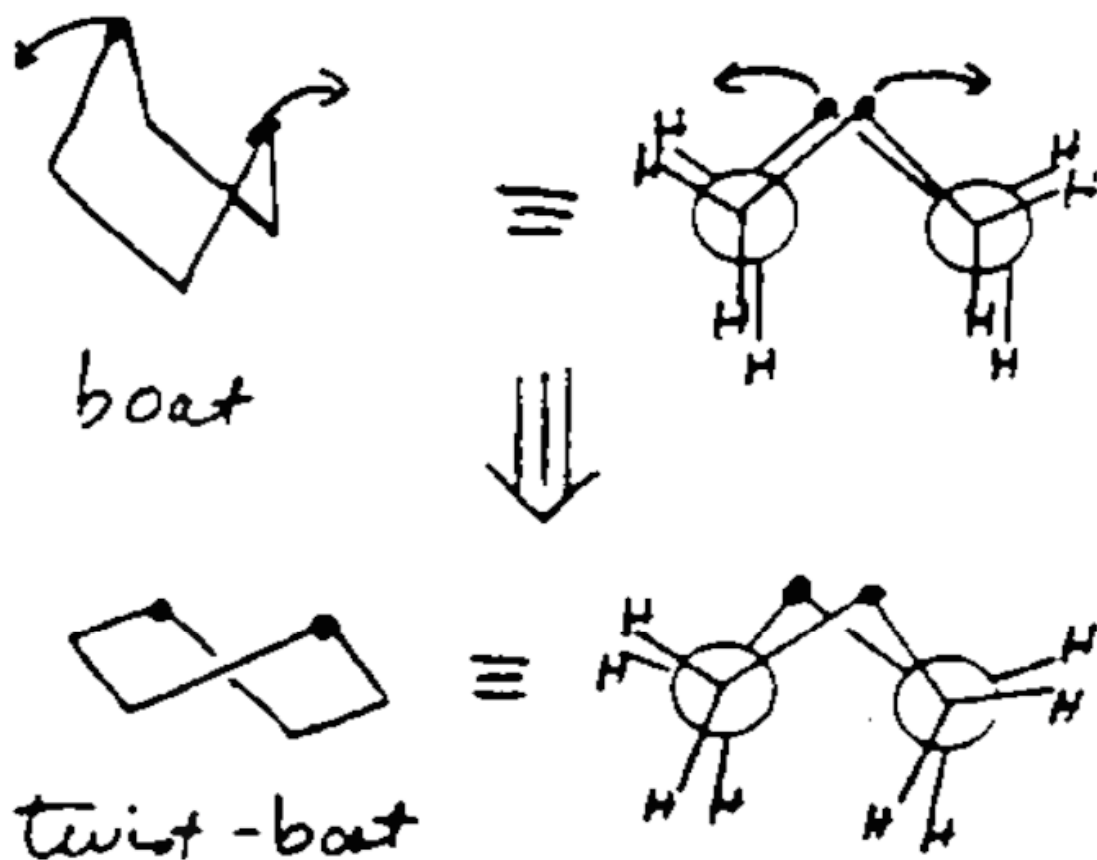
2.56 Energy diagram showing the different conformations of cyclohexane which form during ring-flipping.



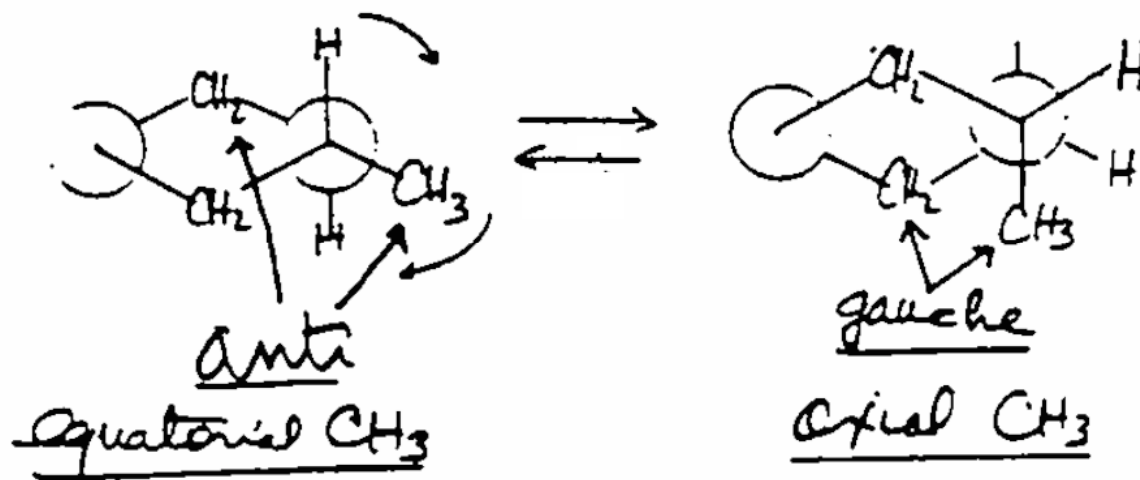
2.57 "boat"



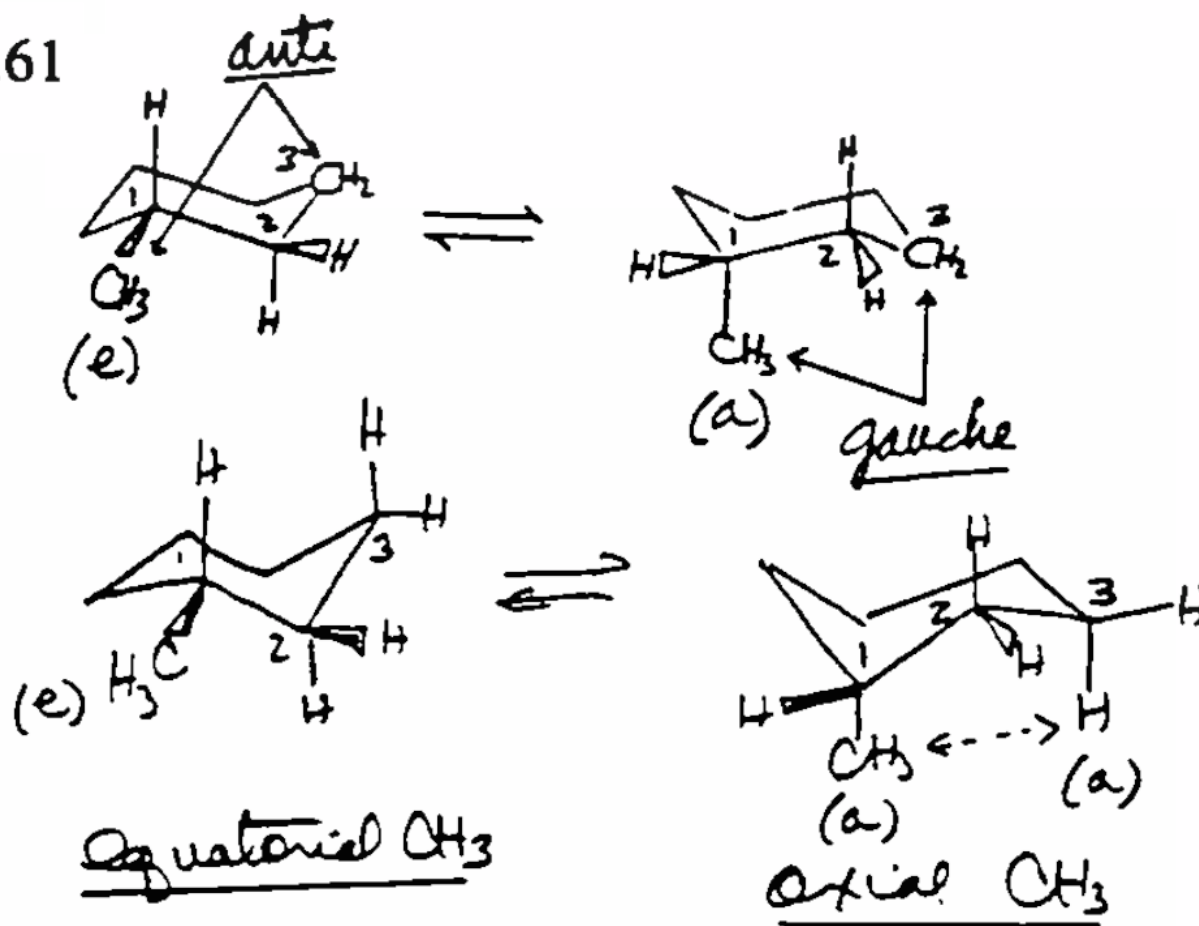
2.58 Formation of twist-boat from boat conformation of cyclohexane.



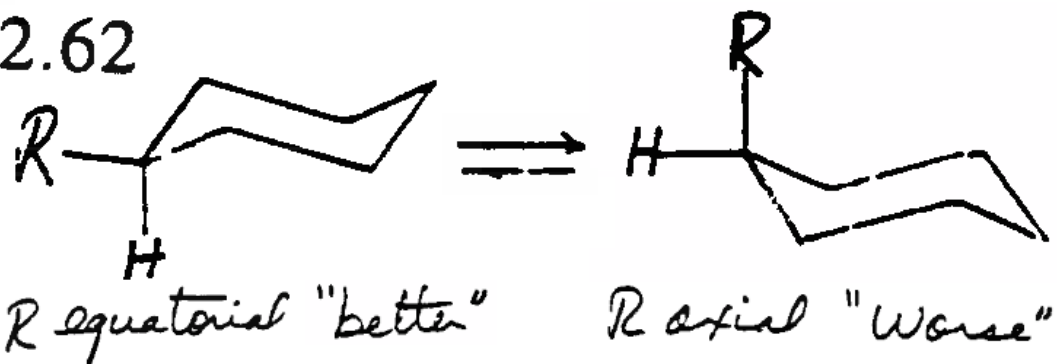
2.60 "Newman-type" projections of methylcyclohexane showing CH₃ in equatorial and axial positions.



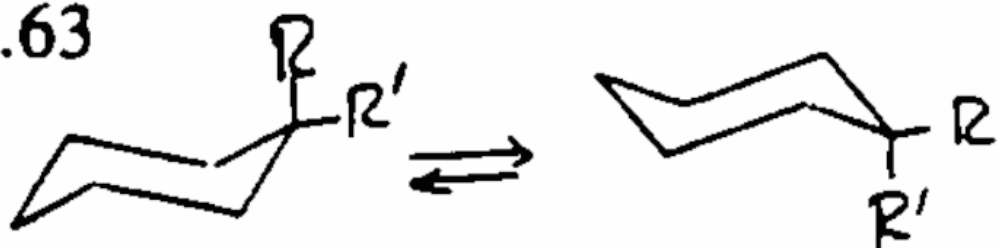
2.61



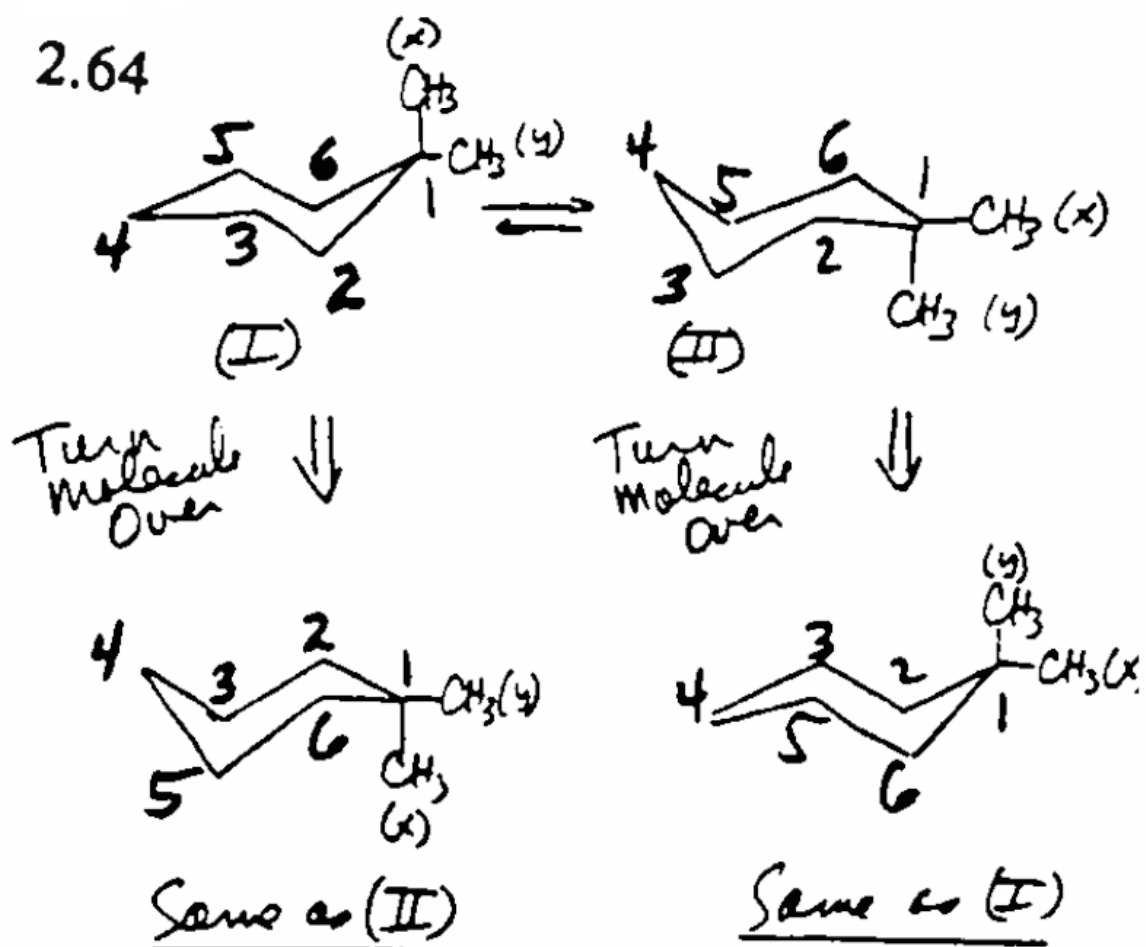
2.62



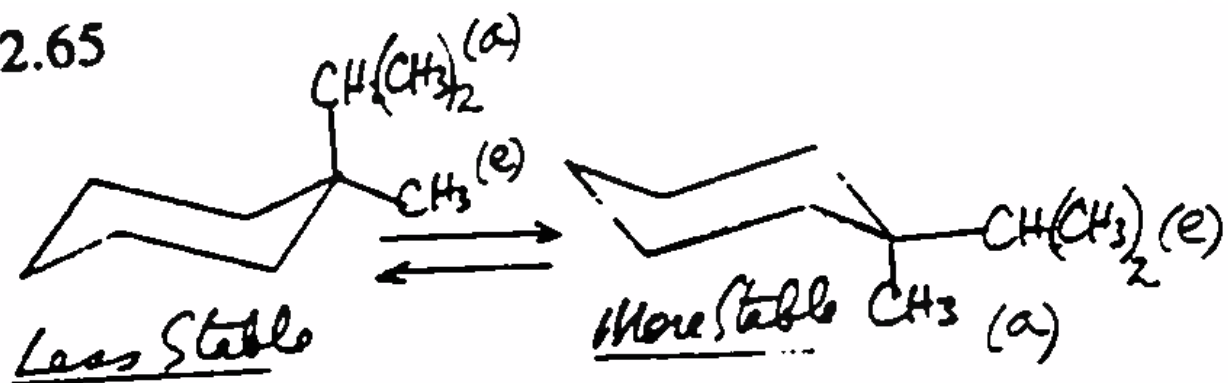
2.63



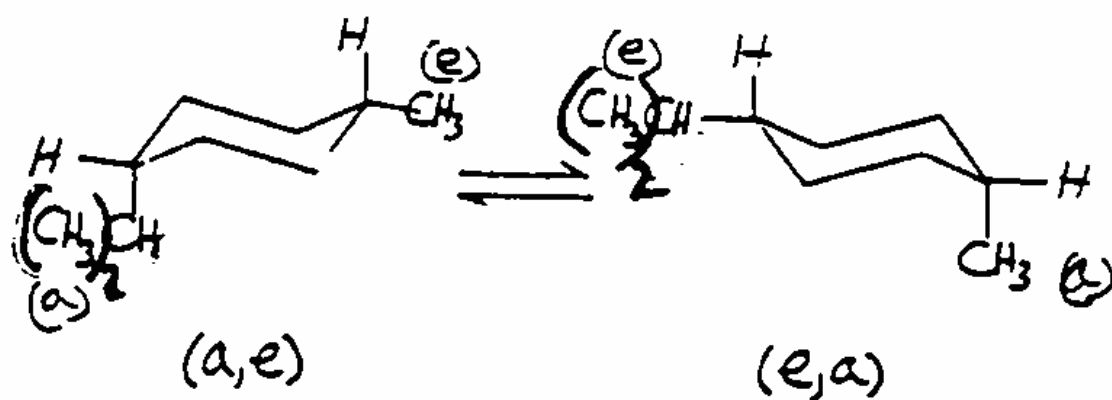
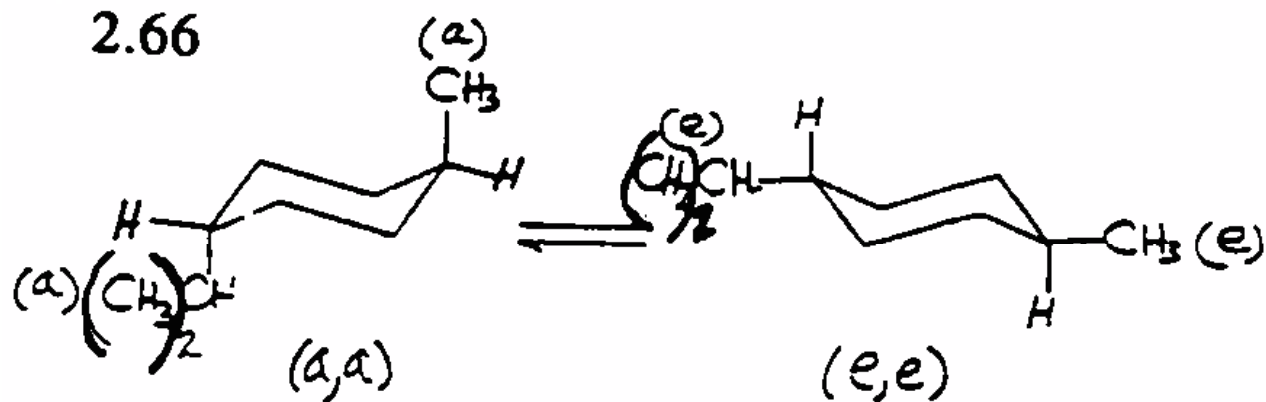
2.64



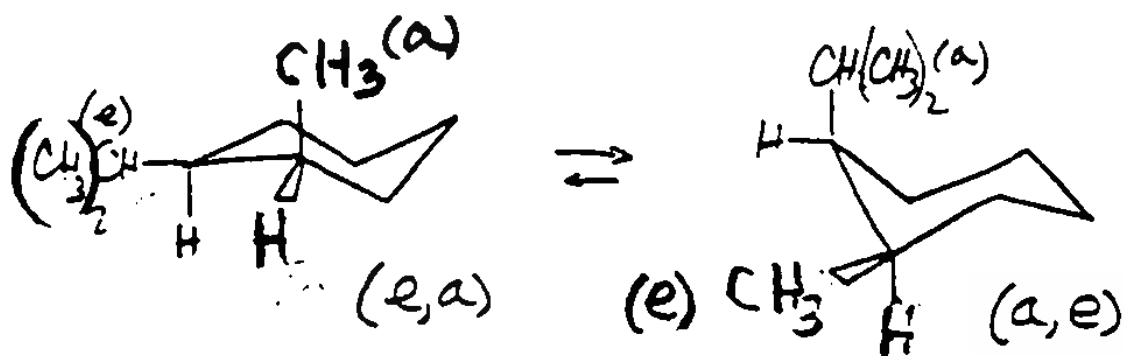
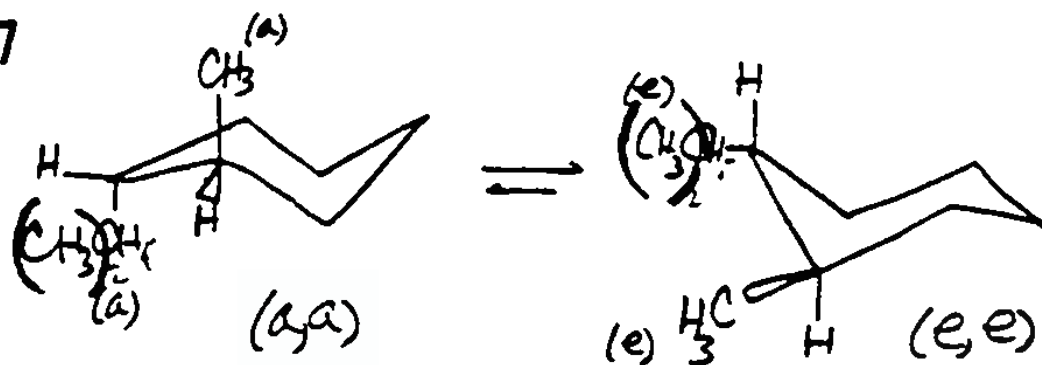
2.65



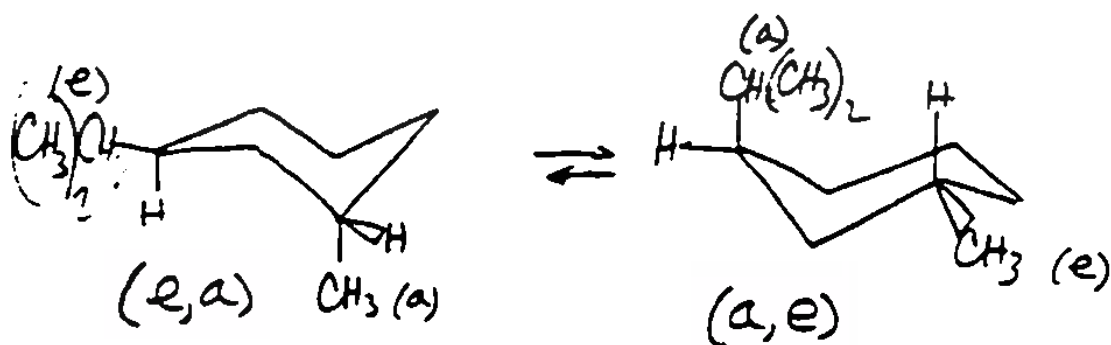
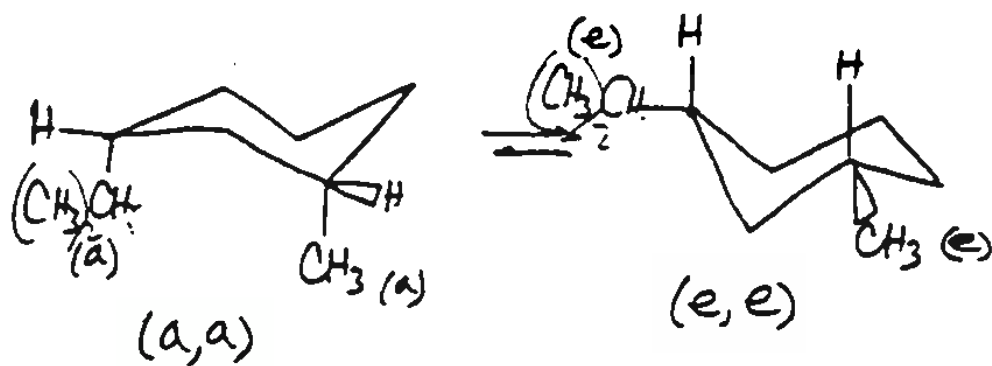
2.66



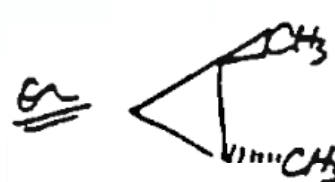
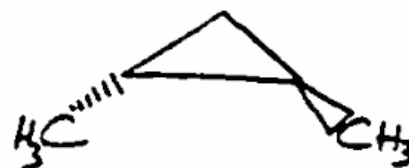
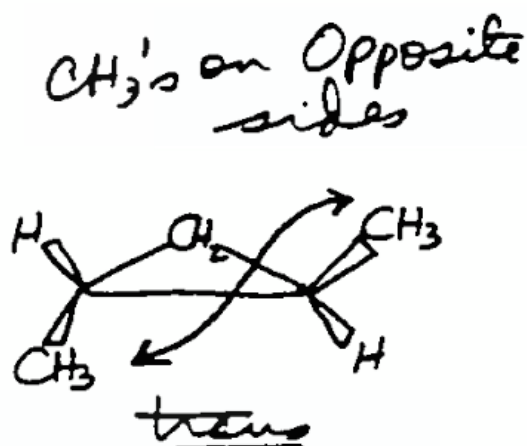
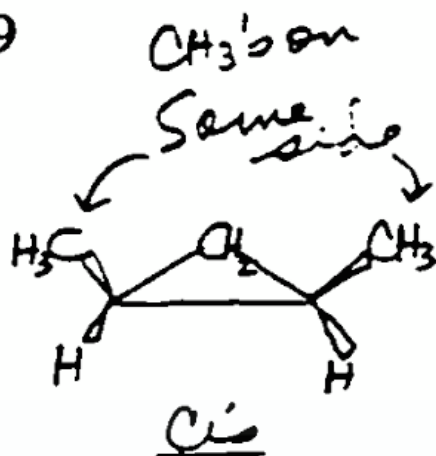
2.67



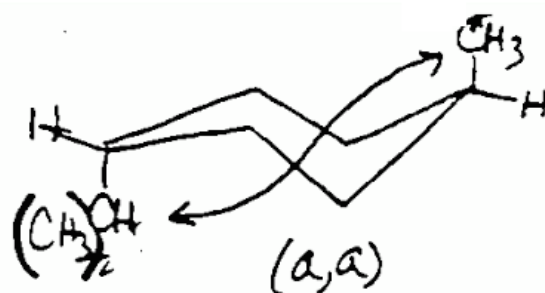
2.68



2.69



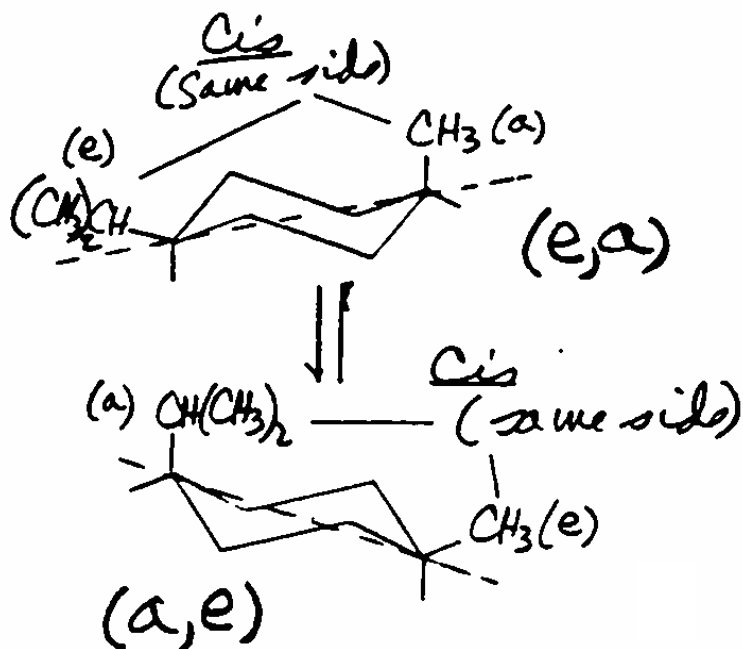
2.70. (a,a) Conformation of
1-isopropyl-4-methylcyclohexane



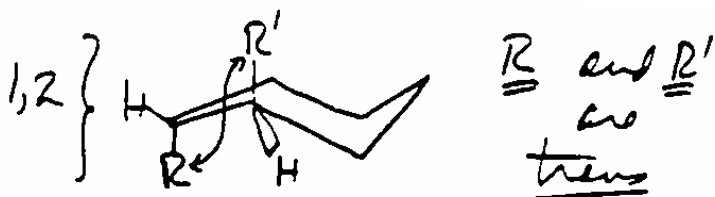
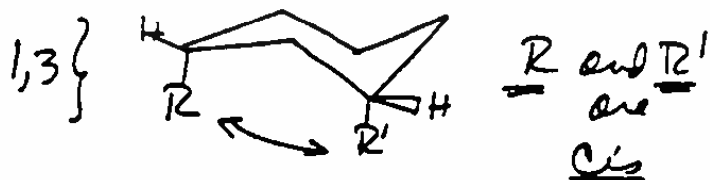
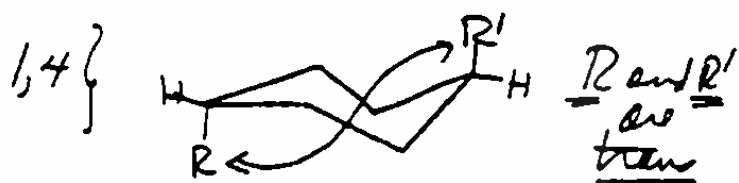
The alkyl groups are trans

Therefore $(a,a) \Rightarrow (e,e)$ } trans
 $(a,e) \Rightarrow (e,a)$ } cis

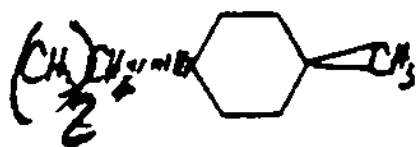
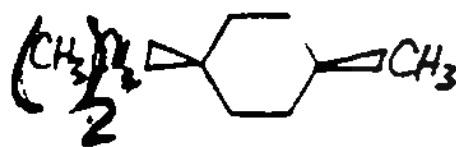
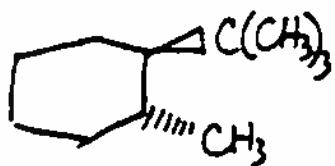
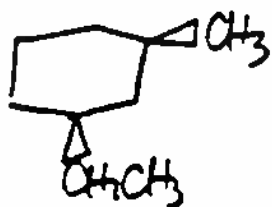
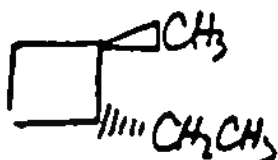
2.70a. (e,a) and (a,e) Conformations of 1-isopropyl-4-methylcyclohexane



2.71. (a,a) Conformations of Dialkylcyclohexanes



2.72

transCisCis-1,2-dimethylcyclohexanetrans-1-*t*-butyl-2-methylcyclohexaneCis-1-ethyl-3-methylcyclohexanetrans-1,2-diethylcyclopentanetrans-1-ethyl-2-methylcyclobutane